GM ENGINEERING STANDARDS	Material Specification	9986496

Adhesive/Sealant, Polyacrylate, Room Temperature Vulcanizing, Alcohol Cure for Axle Sealing

1 Scope

1.1 Material Description. This Polyacrylate (ACM) adhesive/sealant requires no catalyst or heat to cure. When applied it reacts with moisture in the air releasing an alcohol by-product and fully cures to an elastomeric product, adhering to most clean surfaces without need of a primer. Adhesively bonded and fully cured adhesive/sealant acts as a barrier against oil migration across mating surfaces.

1.2 Symbols. Not applicable.

1.3 Applicability. Formed-In-Place Gasket (FIPG) for sealing axle covers, pans or mating of other components for **oil** seal integrity or to restrict dust or unwanted air and water intrusion. This sealant was not developed for engine coolant joints.

1.3.1 Application Temperature and Assembly Sequence. Unless otherwise specified by the adhesive/sealant manufacturer, apply this adhesive/sealant on the intended surface whose temperature is from 20 °C to 40 °C (68 °F to 104 °F). Below 20 °C adhesion and cure rate slows. It is the responsibility of the applicator and the adhesive/sealant manufacturer to establish the accepted conditions, e.g., process time from applied bead to assembly to air test, temperature and adhesive/sealant cure rate to provide acceptable adhesion and leak test performance. See assembly, sealing and fastening Bill of Material (BOM) Level II for minimum process time.

1.3.1.1 Continuous Usage Temperature. Up to +150 °C as defined by SAE J2236 (see 3.2.2.1 and Table 5). Use temperature is a material strength measurement, not related to adhesion performance.

1.3.2 Other Surface Treatments. The adhesive/sealant approved to this standard must be applied after paint or coated part treatments (e.g., Electrocoat Paint Operation (ELPO)/Uniprime coatings of stamped steel covers). It is the responsibility of the applicator and the adhesive/sealant manufacturer to establish the accepted conditions, e.g., time, temperature and coating cure to provide acceptable adhesion and leak test performance.

1.3.3 Cleanliness of Mating Joint Surfaces. It is the responsibility of the applicator and the adhesive/sealant manufacturer to establish the accepted surface conditions, e.g., washer cleaner concentrations, drying time, and storage protection from airborne contaminants to provide acceptable adhesion and leak test performance.

1.3.3.1 Monitoring Cleaning/Washing System Changes on Adhesion. GM retains the responsibility to evaluate changes in chemical cleaning/washing systems over time for parts where sealant is applied. Any changes in these systems must be supported by lap shear data to evaluate the effect on sealant adhesion. Run the appropriate Table 2 test panels through the relevant washer system changes in production scale or in a pilot size operation. The values must meet or exceed Table 5 values. Any joints receiving plasma treatment as a surface preparation method in production, do not require data monitoring of a change in cleaner/washer.

1.3.4 Gap Limitations. Adhesive/sealant is capable of sealing a gap from 0.1 mm to 0.5 mm (the blowout test determines the maximum gap).

1.3.5 Product Advantages. Unlike silicone sealant chemistry, Polyacrylate sealant poses no risk for increased oil foaming due to oil absorption and extraction during curing.

1.4 Remarks. The words **must, shall** or **will** as used in this document mean a mandatory requirement.

1.4.1 Polyacrylate (ACM) sealant will cost more per application versus current production silicone sealants. Once production costs are developed more accurate information will be provided.

1.4.2 Process Behavior.

1.4.2.1 Cure Rate. This adhesive/sealant is slower than most silicone adhesive/sealants from 10% to 100% Relative Humidity (RH). Depth of cure inward from an exposed 1 mm edge for seven (7) days at 25 °C, 50% RH is 10 mm (see 3.2.2.4 and 7.1 Glossary "Cure Speed").

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1.4.2.2 Open Time to Joint Assembly. All Room Temperature Vulcanizing (RTV) silicone sealant joints must be closed and clamped within 15 minutes of the sealant application to the mating flange. Clamped is defined as having a minimum of 80% of the fasteners tightened to the final torque with no two (2) adjacent fasteners untightened. Until production experience provides better information.

1.4.2.3 Shelf-Life Limitations. This sealant is packaged in service and repair cartridges with foil sealed ends. With proper storage the un-opened sealed packaging has a nine (9) month shelf-life. Once opened, shelf-life is limited by how well the opened container is protected against moisture before it is emptied.

1.4.2.3.1 Large Scale Operations. Due to the moisture sensitivity of this sealant, use small pails (20 L/5 gal maximum) with strict limits on storage stock rotation. Product left in delivery lines over extended holiday periods may require a purge.

1.4.2.4 GM materials engineering recommends all RTV adhesive/sealant (regardless of cure system) be used in a ventilated area.

1.4.3 Joint Performance. This adhesive/sealant has low lateral joint movement (onset of cohesive or adhesive failure) on metal substrates due to its low elongation. The shear strength in mega-pascals is high to achieve separation compared to silicone sealants suggesting good bond strength.

Follow these joint strategies (see 1.4.3a thru 1.4.3d) when using this sealant to reduce leak risk.

a. Machined surfaces to tight tolerances. Avoid joints with high stack tolerance variation as the maximum recommended gap is 0.5 mm. Higher gaps (1.0 mm) are possible with the use of surface treatments and/or wider flanges (8 mm or more).

b. Joint metals with low thermal expansion behavior.

c. Wide flange joints with close bolt patterns. The joint flange width shall be 5 mm or more with bolt pattern width not exceeding 80 mm between any two bolts centers on the joint.

d. A step chamfer is recommended by the adhesive/sealant manufacturer to maximize joint movement capabilities of the sealant.

1.4.4 Proper Use of Test Methods. Testing for this standard is based on coupon surfaces and conditions different from those of assembly or service. Standard tests permit comparison between products while attempting to represent a worse case condition related to end use. Testing actual production processes, design (chamfer) and surfaces is necessary before actions are taken. Use the test matched with the desired property/definition.

Note: For example; lap shear strength may be used to measure the effect of sealant and/or process variation (e.g., ineffective surface cleanliness, build variations, etc.,) on bond strength provided it mimics the actual production application with all its known variables. Lap shear is a cured property, not a wet uncured characteristic.

1.4.5 Surface Treatments to Promote Joint Adhesion. Demanding and enforcing part cleaning control through cleaning process specifications is necessary for optimum sealant to joint bond life. Surface treatment chemicals (e.g., Henkel Bonderite) formulated for specific base metals are applied in washer systems or by liquid soaked applicator to maximize bond performance. These are not cleaners, as they are only effective on a washed surface, but properly applied and protected may be globally shipped and perform long after the application.

1.4.6 Adhesive Failure. This sealant lap shear testing to the indicated substrates (see Table 5, Note) produced adhesive not cohesive separation from the test panel substrates. Testing of production surfaces for adhesion evaluation is mandatory for axle joints. The results on axle joints exposed to production intent conditions will dictate use.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM C679	ASTM D1002	ISO 845	SAE J1864
ASTM C1183	ASTM D3677	ISO 4587	SAE J2236
ASTM D297	ASTM D4339	ISO 4650	SAE J2643
ASTM D412	ASTM F2523	MIL-A-46146	

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ASTM D429	IEEE/ASTM SI 10	SAE 1008/1010	
ASTM D471 (SF105)	ISO 37	SAE J243	

2.2 GM Standards/Specifications.

9982257	GMW3016	GMW15735	GMW17224
9985776	GMW3059	GMW16678	GMW17332
9986350	GMW3155	GMW16855	
9986444	GMW14270	GMW17205	

2.3 Additional References.

- Akron Rubber Development Lab (SAE J2643 Molded Rubber Slabs), 2887 Gilchrist Road, Akron, Ohio 44305
- American Petroleum Institute (API), 1220 L Street, North West, Washington DC, 20005-4070 United States
- Assembly, Sealing and Fastening Bill of Materials (BOM) Level II
- Global Document Management (GDM) System
- GM Regulatory Resources (GMR2) Program - portal (https://gmr2.ttsvcs.com/gmr2portal/Home.aspx)
- List of Current Factory Fill Oils (see General Motors Powertrain (GMPT) Materials Engineering Fuels/Fluids/Lubricants and Chemistry Laboratories Group specification 9986444)
- Panel Source: ACT Test Panel, 273 Industrial Drive, Hillsdale, Michigan 49242 or https://www.acttestpanels.com/
- Panel Source: Q-Panel 800 Canterbury Road, Westlake, Ohio 44145-1419 United States of America or www.q-lab.com
- Supplier Process Control Plan
- TETRA Technologies Incorporated Engineering and Consulting Services, 710 Avis Drive, Ann Arbor, Michigan 48108

3 Requirements

3.1 Requirements on Test Specimens. Test specimens shall be prepared by the adhesive/sealant supplier according to their established process or practices. Cure for seven (7) days unless otherwise specified, followed by conditioning for 1 h to 24 h at 23 °C ± 3 °C, Relative Humidity (RH) 50% ± 5%.

3.1.1 Bulk test specimens slab thickness shall be 2.0 mm ± 0.5 mm with no voids or densification lines in an area convenient to the manufacturer.

3.1.2 Test Units. If practical, report data in the appropriate International System of Units (SI) using the latest Institute of Electrical and Electronics Engineers/ASTM international (IEEE/ASTM SI 10) document.

3.1.3 Test Conditions. Unless otherwise specified, testing shall be conducted at 50% RH and 23 °C. If temperature and humidity are known not to significantly affect test results, use a relative humidity range of 20% to 90% and temperature range of 20 °C to 32 °C. All test conditions must be within ± 2 h, ± 2 °C and ± 5% RH of the specified numbers unless otherwise indicated.

3.1.4 Test Frequency. Tests 3.2a should be identified in the Supplier Process Control Plan and performed at the frequency indicated once the requirements of "Material Properties – Uncured" (see 3.2a) are complete.

3.1.4.1 Run every batch or lot by the adhesive manufacturer to test color, homogeneity, inclusions, relative density (specific gravity), viscosity (application rate) and tack free time.

3.1.4.2 Test stability and extrusion rate at a suitable frequency by assembly plant personnel or adhesive/sealant manufacturer until the process conditions, amount and location of adhesive variables are known to ensure compliance. End testing once documented testing data and evidence of process controls are in place.

3.1.4.3 All other tests are once for initial approval.

3.1.5 Sealant Compliance to Document References and Changes. Use the latest published version of this standard; 9986496 at the time of submission for approval. After initial approval, the purpose of this subsection is to manage future changes and provide approved sealant compliance to those changes in a timely manner.

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3.1.5.1 Role and Responsibility. After initial approval if the referenced standard changes, GM Powertrain expects the sealant supplier to monitor industry standard documents for changes and evaluate the impact of the change to determine if it affects required limits. GM is responsible for timely notification to suppliers of its own test standards referenced in this document.

3.1.5.2 New Data Requirements and Timing. A change herein is defined as procedural and/or a new limit or range requirement. Data is required only where the change level affects specified limits. A sealant supplier only needs to acknowledge awareness and use for procedure only change(s) that do not produce a requirement change (e.g., conversion of a regional to a global standard). A supplier is only required to run or acknowledge a change(s) that occurred since their initial full data approval. Data must be submitted to GM Driveline Material Engineering within 180 business days of the published revision (dd/mm/yy) in the GM Global Document Management (GDM) system for GM standards or date document arrives at the external standards contract distributor. Time limits may be extended for regulatory health and safety issues only. No testing is required if the revised document has no changes (revision date only change) or the changes don't involve fit, form or function as defined in GMW17205.

3.1.5.3 How Document Changes Affect Sealant Compliance. All product produced after the changes are published in GDM shall meet the new requirements. Product approved under the previous edition requirements and already in the delivery pipeline or in inventory will be used until the product expiration date is reached or the product is used. Decisions involving regulatory changes will be handled separately and existing product may be immediately removed as a result.

3.1.5.4 Table Requirements. Sealant tests and development for this 9986496 standard are derived from GMW16855, requirements for axle sealing, one component RTV sealant for axle sealing. Changes to GMW16855 must be monitored in accordance to 3.1.4. The Table 1 properties in this 9986496 standard represent only those GMW16855 tests that required data for the specific product and/or the accepted deviations between GM Powertrain Engine Materials Engineering and the sealant manufacturer. The GMW16855 tests that have specified limits (denoting exceptions) will be run in advance of this 9986496 document. These tests will be listed in Table 1 in ***bold italics*** to confirm their acceptable completion (see Table 1, Note).

3.2 Requirements on Delivery.

a. Material Properties; Uncured, see Table 1.

b. Material Properties; Cured, see Table 5.

3.2.1 Requirements; Uncured (see Table 1).

3.2.1.1 Blowout. Modified ASTM F2523 fixtures with 30 degree and 45 degree chamfer (see Appendix A, Figure A2).

3.2.1.2 Color. See Table 1. Properties are based on this color.

3.2.1.3 Viscosity. See Table 1 Extrusion Rate.

3.2.1.4 Homogeneity. Using the setup in Figure 1 of GMW17224, spread the adhesive/sealant on the flat surface. The adhesive/sealant shall be homogeneous, without lumps, gas bubbles, and/or inclusions.

3.2.1.5 Noncorrosive to Metals. See Appendix A, A1.2 for procedure. Evaluate the compatibility of cure reaction by-product with metals and note: C1 = Copper, C2 = SAE 1008/1010, Steel, C3 = AA319 or AA356T6 Aluminum, C4 = Other. If metals are coated, test on production approved coating.

3.2.1.6 Odor (ASTM D4339). Material shall not have an objectionable odor in the uncured state and shall not have a perceptible odor after cure. Use the previously approved production adhesive/sealant as a reference (e.g., 9982257 or 9986350).

3.2.1.7 Oil Gel Test. No gel must be formed after following the Appendix A, A1.1 procedure run at 23 °C ± 2 °C temperature and 50% RH ± 5% RH. Run GM 9986444 oil unless otherwise specified. Since factory fill oil may change over time, before testing see General Motors Driveline Materials Engineering Fuels/Fluids/Lubricants and Chemistry Laboratories Group for a List of Current Factory Fill Oils.

3.2.1.8 Specific Gravity. To be determined, and set as part of the specification, at the time of approval. For uncured adhesive/sealant use the ASTM D297 pycnometer method or ISO 845.

3.2.1.9 Storage Stability (GMW15735, 4.3.2). The material when conditioned to the recommended supplier storage conditions (8 °C to 21 °C) must be capable of passing all the performance requirements in Table 1.

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3.2.1.9.1 Shipping Stability (GMW15735, 4.3.1). As shipped, the material shall be capable of passing all the performance requirements in Table 1. Run the low temperature stability GMW15735 Cycle B.

3.2.1.9.2 Shelf Life. The shelf life of the material, as shipped, in closed containers shall be a minimum of 250 days at a temperature not to exceed 28 °C. Shelf life of the material commences upon receipt of the material from the manufacturer. In such cases where the shelf life exceeds the minimum 250 day requirement, the manufacturer shall identify and affix a "Use By" date on the shipping container that shall establish the shelf life, but in no case shall that be less than the minimum 250 days. Under no circumstances should expired adhesive/sealant be used for production build.

3.2.1.10 Pumpability. The adhesive/sealant shall be able to be applied through current production dispensing systems. No loss in pump output or increase beyond normal wear or service intervals due to adhesive/sealant shall occur.

Table 1: Uncured Adhesive/Sealant Requirements

Property	Test Procedure	Unit	Value
Blowout Resistance	ASTM F2523, Method A, 30 kPa air pressure for 60 s at 0.5 mm gap. Sample obtained by filling an empty cartridge from production dispensing system. Test within 20 minutes of sampling.	Seconds to blowout	No blow out
Color	Visual		Gray
Extrusion Rate			
As Received In Container	ASTM C1183, Use tapered nozzle, 100 mm length and 3.2 mm orifice; 0.62 MPa pressure. Cartridge.	g/minute	40 minimum
Pumped or Sheared	Same conditions. Sample obtained by filling an empty cartridge from production dispensing system. Test within 20 minutes of sampling.	g/minute	40 minimum
Homogeneity	Visual		Homogeneous, Free of Lumps or Air Bubbles
Noncorrosive to Metals	MIL-A-46146, See Appendix A, A1.2.		No Visual Evidence
Odor	ASTM D4339, Reference Current Production Material (9986350)		Lower or Equal to Reference in Parenthesis
Oil Gel Test	See Appendix A, A1.1		No Gel Formation
Pressure Stability	SAE J1864, Alternate Pressure		No Separation or Caking
Specific Gravity	ASTM D297, Hydrostatic Method or ISO 845		1.35 sp.g ± 0.1 sp.g
Sag Resistance	SAE J243, ADS-10, Method C. As received Use pumped sample from extrusion rate test within 20 minutes after sampling.	millimeters (mm)	0.5 maximum 0.5 maximum
Tack Free Time	ASTM C679. Temperature 20 °C to 32 °C, RH 20% to 90%	minutes	35 maximum
Stability	See 3.2.1.9 thru 3.2.1.9.2		Minimum nine (9) months
Volatile Organic Compounds (VOC)	GMW3016, Environmental Protection Agency (EPA) Method 24	Grams/Liter, Percent (g/L%)	18.85, 1.6 Maximum

Note: Tests listed in Table 1, highlighted and in ***bold italics*** *per* the GMW16855 tests that have specified limits (denoting exceptions) will be run in advance of this document.

3.2.2 Requirements; Cured (see Table 5).

3.2.2.1 Continuous Upper Temperature. Test fully cured specimens die-cut from slabs/sheets per 3.1. Follow Table 5 test conditions.

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